Routledge
Taylor & Francis Group

Military Psychology

ISSN: 0899-5605 (Print) 1532-7876 (Online) Journal homepage: http://www.tandfonline.com/loi/hmlp20

Military Job Analysis: A Historical Perspective

Jimmy L. Mitchell & Walter E. Driskill

To cite this article: Jimmy L. Mitchell & Walter E. Driskill (1996) Military Job Analysis: A Historical Perspective, Military Psychology, 8:3, 119-142, DOI: 10.1207/s15327876mp0803_1

To link to this article: https://doi.org/10.1207/s15327876mp0803_1

Published online: 17 Nov 2009.

Submit your article to this journal

Article views: 31

View related articles

Citing articles: 1 View citing articles

Full Terms & Conditions of access and use can be found at
http://www.tandfonline.com/action/journalInformation?journalCode=hmlp20

MILITARY PSYCHOLOGY, 8(3), 119–142
Copyright © 1996, Lawrence Erlbaum Associates, Inc.

Military Job Analysis: A Historical Perspective

Jimmy L. Mitchell
Institute for Job and Occupational Analysis
San Antonio, Texas

Walter E. Driskill
Metrica, Inc.
San Antonio, Texas

The U.S. military services pioneered the development of several job and occupational analysis methods and the application of these technologies. These job analysis techniques evolved to meet a variety of human resource planning and management needs, particularly reviewing classification structure and validating specialty initial skills training programs. A task inventory approach was useful for most military needs, and this approach was developed into a comprehensive occupational data analysis system. Task performance data (percentage performing each task, relative time spent) were later supplemented with task factor ratings (by a subset of experienced technical specialists), such as task difficulty and training emphasis recommended for the training of new personnel. As military budgets are increasingly constrained, these types of data, as well as new kinds of task and task module level information (such as associated skills, knowledges, equipment utilized, etc.), become critical for assisting military decision makers in modeling how to restructure occupations and optimally allocate scarce manpower and training resources. There is the potential for considerable general utility to the country as a whole in military and civilian use of such task and task module technologies for the study of jobs, occupations, and organizations.

Requests for reprints should be sent to Jimmy L. Mitchell, Institute for Job and Occupational Analysis, 10010 San Pedro, Suite 400–6, San Antonio, TX 78216–3862. E-mail: IJOHALM@AOL.com

Job analysis has been defined as the collection and analysis of any type of job-related information by any method for any purpose (McCormick & Tiffin, 1974). Because jobs are the basic building blocks of organizations and work groups for the accomplishment of meaningful work (Ash, 1988), job analysis is a tool that provides an informational base for a wide variety of organizational and managerial purposes. Implicit in any selection, classification, or training process is the identification, through systematic job analysis techniques, of the tasks, skills, knowledge, or abilities required to perform a job (Mitchell, Ruck, & Driskill, 1988). The military services have been in the forefront of the development of systematic task, job, and occupational information, and in the use of such information in selection, classification, placement, training, and evaluation (Christal, 1974b; Morsh, 1964). For the most part, the development of job and occupational analysis in the military services has been extremely pragmatic, that is, the development of detailed data appropriate for very specific uses.

HISTORICAL EVOLUTION OF MILITARY JOB ANALYSIS

Primoff and Fine (1988) observed that "the history of job analysis is essentially a history of individuals undertaking to satisfy certain needs for information about jobs in order to deal with practical personnel problems" (p. 14). They credited the civil service reform movement after the Civil War for creating the drive for more realistic job information and better personnel selection as an alternative to the political spoils system for filling federal jobs. They also noted that

> Initially, the methods used to obtain the information appear to have been readily available observation, interviewing techniques with knowledgeable people, or simply deduction based on assumed knowledge. Only in the past century with the introduction of scientific management, has there been a focus on the methodologies of fact gathering as such. (p. 14)

World War I

During World War I, the misuse of personnel was widespread primarily because of a lack of definition of job requirements (i.e., lack of systematic job analysis). Walter Dill Scott and Walter VanDyke Bingham headed the Committee on Classification, a group of noted psychologists who were charged with improving personnel testing and placement for the U.S. Army. This project resulted in the Army Alpha and Beta tests for selection and classification of recruits (DuBois, 1970). After the war, Scott recommended an integrated personnel system with complete cross-referencing between military and civilian skills and specifications

for each type of job; he also suggested trade tests to determine individual skill levels (Blum & Naylor, 1968). Scott's approach can be interpreted as a seminal attempt to match people and jobs properly in order to optimize individual and organizational performance and to provide for systematic individual development (Mitchell, 1988).

Between the Wars

Shortly after the end of World War I, Scott set up his own company and introduced job analysis procedures to business and industry in terms of major duties and responsibilities. In 1922, the U.S. Civil Service Commission tasked R. C. Clothier, a vice president of the Scott Company, to analyze the jobs of 1,200 civilian employees in 237 occupations at McCook Field, Dayton, Ohio, in terms of their duties, requirements, and avenues of advancement (Primoff & Fine, 1988). A prime objective of this extremely successful study was to classify occupations and identify grade levels (career progression paths) within each occupation.

In the early 1930s, the Social Science Research Council and the National Research Council were concerned with improving job analysis for classification and placement to help remediate unemployment. This emphasis led to the development of the Occupational Analysis Program (OAP, later titled the Occupational Analysis Section) of the U.S. Employment Service (USES) in 1934. The OAP was headed by C. L. Shartle until the early days of World War II (Primoff & Fine, 1988). A number of psychologists who would later pioneer job analysis methodologies of their own got their start in the USES OAP, including E. J. McCormick, E. S. Primoff, and S. Fine (see Gael, 1988).

World War II and Subsequent Developments

During World War II, psychologists were used extensively to help improve the selection and placement of military personnel as well as to improve the human factors engineering of new equipment systems (Miller, 1953; Moore, 1976). McCormick (1967) noted that this military work "was then the most extensive program in personnel classification and assignment the world has ever known." He went on to say that "despite the criticisms to the contrary, both well-founded and not, it is at least my own personal conviction that those classification programs contributed significantly to the effectiveness with which the military services girded themselves for that unhappy period" (p. 121). He cited the development of a pilot selection program by Flanagan (1951) and his coworkers at Lackland Air Force Base, Texas, as an example of significant improvement. Flanagan subsequently used similar methods, which he called a critical incident technique, to analyze

administrative and research and development officers' jobs, thus creating another job analysis methodology.

As early as 1946, Shartle called for the establishment of a national center for job analysis; he believed an integrated approach was essential to derive proper occupational information and optimize its use (Shartle, 1959). Shartle stressed the need for a "systems approach" to the study of American jobs and occupations; he felt that to study just one aspect (such as selection or training) would result in an incomplete understanding of job requirements.

In an August 1949 memorandum from the Joint Chiefs of Staff to the Secretary of Defense, a request was made to

> initiate a study to determine the most appropriate methodology and techniques of military job analysis and job evaluation; determine the extent to which the unilateral analyses accomplished to date are valid with relation to methodology; provide for such further job analysis as may be required; and initiate a study to relate all Army, Navy, and Air Force jobs to a common occupational structure. (Van Cleve, 1974, p. 65)

In the early 1950s, Rupe (1952, 1956) studied several Air Force job analysis methods and recommended the adoption of a checklist survey method. This suggestion met considerable resistance even though several members of the Air Staff pleaded for an aggressive occupational research program (Christal, 1974a). Throughout the 1950s and 1960s, several military job analysis methodologies continued to be used by the various services (such as billet-by-billet audits, analysts' interviews, etc.); some of these methods proved difficult to use or too expensive to sustain (Van Cleve, 1974). In late 1957, Headquarters USAF directed that an occupational research project be established within the Personnel Research Laboratory (which later became the Air Force Human Resources Laboratory and today is the Human Resources Directorate of the Armstrong Laboratory). It took another 10 years to develop an operational Air Force occupational analysis program; the program was finally implemented in July 1967. This program included initial operational use of the Comprehensive Occupational Data Analysis Programs (CODAP), a very powerful set of computer programs used to process, summarize, and display extensive sets and subsets of complex occupational data. A number of additional years were required for CODAP to be institutionalized in the classification and training communities within the Air Force (Christal, 1974b; Morsh, 1964).

The advantage offered by the Air Force's task inventory, CODAP-based program is the capability for obtaining and analyzing detailed task information from large numbers of job incumbents. Of this work, McCormick (1967) wrote:

> The pioneering work of the Personnel Research Laboratory ... is particularly noteworthy. They have developed and used job inventories, consisting of lists of job tasks in a given career field, as a means of mass collection of job information from job

> incumbents. This technique, in combination with certain associated statistical procedures (which they also developed), has made it possible to describe jobs in quantitative terms and to express job relationships in quantitative terms. (p. 122)

It is the task-based CODAP procedure that has generally been adopted by the U.S. and Allied military services. Before examining this approach in detail, it is appropriate to have some background in other job analytic approaches and to review the status of general theoretical developments among the various approaches.

JOB ANALYTIC APPROACHES

Types of Approaches

Fleishman and Quaintance (1984) suggested that job analysis methods can be classified into four categories: behavioral description, behavioral requirements, abilities requirements, and task characteristics.

Behavioral description methods focus on specifying what workers actually do while performing their jobs. Products of these methods range from highly task-specific to more general task information. Emphasis usually is placed primarily on the overt behaviors or certain subjective terms that describe what the worker does. Several systems of job analysis representing this approach are in use, each differing from the others with respect to the level and context of the descriptive information. Included under this approach are the task inventory-CODAP approach, the Position Analysis Questionnaire (McCormick, 1979), Occupational Analysis Inventory (Cunningham, 1988), General Work Inventory (Cunningham, Wimpee, & Ballentine, 1990), Job Element Method used by the Department of Labor, and Functional Job Analysis (Fine, 1988; Fine & Wiley, 1971). These methods are well documented with regard to measurement issues, interrater reliability and taxonomic adequacy, job component and criterion-related validity, and utility (Driskill, Weissmuller, Hageman, & Barrett, 1989; Gael, 1988).

Behavioral requirements methods place emphasis on the classification of worker behaviors that are required for achieving desired or expected levels of performance. The human performer is assumed to be in possession of a large number of processes that serve to intervene between stimulus and response events. These intervening processes are in a real sense behavioral constructs that are needed to account for human task behavior. Such approaches, perhaps best described by the methods of Gagne (1977) and Miller (1973), have most generally been applied to the problem of human learning and human factors engineering analysis.

Abilities requirements methods describe, contrast, and compare jobs and tasks in terms of abilities required of the worker. Abilities as defined by Fleishman and

Mumford (1988) and McCormick (1979) are the relatively enduring attributes of the individual performing the tasks of an occupation, and certain tasks are hypothesized as requiring certain ability profiles if performance is to be maximized. This approach is best exemplified by Fleishman and Mumford's Ability Requirements Scales (ARS) system. The ARS consists of a taxonomy of sensory, perceptual, cognitive, and physical abilities that raters use to describe human task performance requirements. Fleishman recently modified the system to include general knowledge and a number of skills in his taxonomy (Fleishman & Reilly, 1992). This taxonomy is one of the most widely used systems for defining abilities required in the world of work.

Task characteristics methods emphasize analysis of tasks in terms of their characteristics and their impacts on behavior and performance. A taxonomy of task characteristics includes such features as number of procedural steps, dependency of procedural steps, response rate, procedural complexity, and amount of feedback provided to the performer by successful (or unsuccessful) outcomes (Driskill et al., 1989). Use of the task characteristics approach produced important implications for learning and retention. A study in which hands-on performance measures were the criteria (Rose et al., 1984) suggested that the characteristics of tasks may be the very best predictors of retention.

The various approaches or methods of job analysis result, in part, from differing perspectives on the world of work and from the different purposes for which job analyses are conducted. In some instances such perspectives and purposes are explicitly stated; in many other instances they are implicit in the approach taken to analyze jobs even though they may not be specifically stated.

MILITARY JOB ANALYSIS: THE TASK INVENTORY APPROACH

The task-based approach has proven exceptionally useful in the military services for establishing which tasks are performed in common by most job incumbents within an occupational category (specialty); such common tasks are the most realistic focus for initial skills training programs. Other tasks, performed only by a subset of the population of an occupation, are more realistically trained in a specialized course or through on-the-job training.

Given the sizable numbers of personnel entering the military services each year and the increasing pressure of budget constraints, the proper identification of which tasks should be trained is an issue of critical importance. Billions of dollars have been and are being spent on military training each year, and this level of outlay will continue into the foreseeable future. In times of decreasing military budgets, it is

imperative that military policy makers have the best possible information on which to base decisions about allocating scarce training dollars.

Given the critical importance of systematic, task-based job analysis data, how is such detailed and complex information developed and how can such data best be used? The development of the task-based approach came about when the need for properly managing personnel in a rapidly changing, high-technology military workplace became clear (Rupe, 1956; Thorndike, Hagen, Orr, & Rosner, 1957). These demands generally fell into the broad categories of selection, classification, job evaluation, testing, and training.

Early in this line of research it became obvious that a detailed understanding of Air Force jobs was essential to all these goals (Morsh, Madden, & Christal, 1961). At the same time, the potential impact of the electronic digital computer was being recognized (Christal, 1974b). Although all the problem areas were being researched, the first gains were in the area of classification. These gains were due, in part, to two major advances. The first was the validation of scientific methods for developing standardized, individual job descriptions (Archer, 1966; Archer & Fruchter, 1963). The second was the development of hierarchical clustering, an analytic tool that used those descriptions to define empirical subdivisions of given occupational areas (Ward, 1961).

Early studies showed that the best information for classification purposes was data collected directly from job incumbents on the relative amount of time spent on tasks (McCormick, 1960; McCormick & Tombrink, 1960). By collecting, summarizing, and displaying information about the tasks being performed by various groups within an occupation and the relative amount of work time spent on such tasks, decisions could be made about how the occupation should be appropriately organized and described. Such data could be used directly to evaluate career field documents and specifications as well as to review occupational training programs.

Task Factor Information

More information is needed for prioritizing training requirements than simply which tasks are performed by what percentage of personnel in a specialty. Many of the early studies also examined job incumbents' self-reports of training needs without much success (i.e., little agreement on what and how to train). These studies included analysis of task "physical difficulty" and "mental difficulty." Other early studies examined self-reports of task "training emphasis," "difficulty to learn on on-the-job training" (Madden, 1962; Morsh, 1965), and "worker–supervisor agreement on difficulty" (Madden, Hazel, & Christal, 1964). Based on this research, it was decided that training requirements and priorities information would best be collected from experienced senior technical personnel.

Using first-line work leaders and supervisors as raters, several scales were evaluated and subjected to interrater agreement analyses. It became clear that the concept of difficulty was multidimensional and that refinement of that concept was required in order to develop an operational system. It was determined that a measure of task learning difficulty would best serve the needs of the training community (Christal, 1974b). First, it provided a stable, usable measure that could be collected operationally. Second, a definition of difficulty had the desirable implication of relating individual learning ability to an appropriate course length.

Although all operational data collection had been on a relative scale within one or two highly related career fields, Air Force researchers also studied whether these data could be used across many, if not all, career areas (Burtch, 1978; Fugill, 1972, 1973). The goal of the benchmark scale was to develop measures that could prioritize Air Force career fields in terms of learning difficulty. In addition, this measure could, on a standard scale, demonstrate the diversity of learning difficulty requirements within a career field and, perhaps, suggest classification changes.

Benchmark scales were produced for the major aptitude areas of the Armed Services Vocational Aptitude Battery (ASVAB): Administrative, General, Electronic, and Mechanical (Garcia, Ruck, & Weeks, 1985). The Administrative and General areas were then combined to yield three major areas: General, Electronic, and Mechanical (Ramadge, 1987). Tasks spanning the spectrum of within-specialty difficulty were selected for study. Researchers made field visits to observe the performance of the selected tasks and rated them on the appropriate 25-point benchmark scale. Regression equations were developed to predict the 25-point benchmark ratings from the corresponding subset of the original senior technician ratings of within-specialty learning difficulty. These regression equations were then used to produce predicted 25-point ratings for all tasks within the original inventory. Subsequently, the 25-point ratings were used to compute a predicted job learning difficulty index on a scale of 10 to 250. The data were summarized for the first-term, five-skill-level airmen within the specialty. The mean and standard deviation of this group has become known as the Occupational Learning Difficulty (OLD) index for these specialties.

Subsequent research (e.g., Weeks, Mumford, & Harding, 1985) demonstrated a construct validity with respect to training course attributes of student input, training outcomes, and course characteristics. Further research is needed to explore the actual trade-off curves in the difficulty–aptitude interaction to enhance the accuracy of the person–job match algorithms.

The importance of the construct of task learning difficulty for Air Force technical training is based on the assumption that it will take longer to learn a more difficult task (Christal, 1974b; Weeks, 1981). This appears to be a well-founded assumption; a corollary that more capable individuals will take less time to learn a task of constant difficulty is well established in the research literature (Cronbach & Snow, 1977). The cognitive literature also supports the concept that time to mastery and

response time may be excellent indicators of problem difficulty both at the individual and the aggregate levels (Sternberg, 1982).

Mumford, Weeks, Harding, and Fleishman (1985) included the construct of occupational difficulty (the aggregate difficulties of tasks performed within a specialty) in a conceptual model of the Air Force initial skills training process. This was done in response to instructional systems design personnel and training managers' contentions that task difficulty had a significant influence on the design of courses and on student performance. Inspection of the data collected in almost 40 training courses supported these a priori expectations, with the more technical courses having higher occupational difficulty indexes than did the less technical courses. A more detailed analysis of these data by Weeks (1984) found that the observed pattern of relations between the occupational difficulty index and several training criteria provided substantiation for the validity of the learning difficulty construct.

The results of a path analysis carried out by Mumford et al. (1985) showed that OLD was a prime determinant of the nature of the training course by influencing course attributes such as course length, student–faculty ratio, instructor quality, amount of feedback provided, and so forth. OLD was shown to have a negative effect on the quality of student performance; that is, the more difficult the tasks within a specialty, the poorer the quality of performance in training. These findings further indicate the importance of task difficulty in Air Force technical training and support the need for further research in the relation between training criteria and the task learning difficulty index (i.e., average task difficulty ratings).

Once task difficulty ratings for specialties have been placed on a common metric (via the benchmarking process), the relative difficulty of typical jobs of all specialties can be compared to develop a rank ordering of the specialties themselves. Management decisions can then be made on the minimum aptitudes required for each specialty (Burtch, Lipscomb, & Wissman, 1982; Fugill, 1972, 1973). OLD data have been used to operationally redefine aptitude requirements, and current standards are being slowly adjusted (5% per year) to meet the new target values (Harding, Mumford, & Weeks, 1985; Weeks, 1984). Use of task difficulty and OLD data affects the total distribution of all incoming Air Force enlisted personnel.

Another type of task factor information collected from senior technicians is ratings of how much training emphasis should be placed on a task in initial skills training, that is, training for the first job or first enlistment (Mitchell, Ruck, & Driskill, 1988; Ruck, Thompson, & Stacy, 1987). Senior noncommissioned officers serving in operational units in each specialty are asked to (a) check each task for which formal training of some kind is recommended for first-term airmen and (b) rate each of the tasks that were checked to reflect the degree of recommended training emphasis (Ruck et al., 1987). Vaughan (1978) noted that the ratings indicate the extent to which emphasis should be placed on each task in formal training for first-assignment airmen (i.e., at the apprentice level). However, the

ratings do not distinguish among the various forms of formal training (e.g., technical school, correspondence course, field training unit, or on-the-job training).

When used in conjunction with information on the percentage of first-assignment airmen performing tasks, training emphasis and task difficulty data can be used to evaluate plans of instruction for basic entry-level courses as well as other training specification documents. The tasks can be reorganized into summaries structured around the documents being evaluated, with task data grouped into appropriate categories for each section or paragraph. This procedure reformats the data into a form that is familiar to the field technician, training developer, or training decision maker, but provides concise summaries of information from a substantial proportion of career field incumbents and senior technicians. By providing data summaries in this way, a direct validation of training in terms of task performed on the job can be achieved. Areas of overtraining and undertraining can be identified as well as groups of tasks that may have been omitted from training specification documents (Chin, Lamb, Bennett, & Vaughan, 1992; Vaughan, 1978).

By reviewing such summaries of occupational analysis data, functional and training managers can direct modifications to training documents and, ultimately, to training programs. These decisions are then validated by meeting with Air Force functional managers and representatives of user commands who employee new specialists. This validation step is normally conducted in a Utilization and Training Workshop (U&TW). Agreements with user organizations represent a contract as to the level of training to be provided in the initial skill acquisition courses. Implicit in this kind of agreement is the promise by user organizations to provide from their own resources any additional training (such as hands-on training and experience with equipment) not provided in the classroom. U&TWs also permit functional managers to develop future organizational plans, such as the impending procurement of new systems or phaseout of obsolete equipment. Thus, occupational analysis data can be tempered by both user judgments and future plans for changes in the technical specialty.

This training emphasis line of research has resulted in a variety of other research and development programs for the prioritization of training, assistance of training decision makers, and restructuring of occupations or specialties. The Training Impact Decisions System (TIDES; see Chin et al., 1992; Mitchell, Yadrick, & Bennett, 1993) is based on the need to have an overall model of each specialty's jobs and training programs; any change in one job or program affects all parts of the Air Force specialty in terms of training costs or capacity. This research and development (R&D) area is too complex to detail here, but some of the newer applications are covered in other sections of this issue. Suffice it to say that for the Air Force, task-based occupational data have been applied in a variety of ways that have substantially enhanced the ability of Air Force decision makers to specify relevant, content-valid, and cost-effective training programs (Stone, Weissmuller, & Mitchell, 1995); more effective recruiting and selection standards (Sellman,

1995); and, potentially, more realistic assessment of individual and organizational productivity (Stone, Turner, Looper, & Skinner, 1994).

Acceptance of the Task-Based Approach

The CODAP work of Christal and his coworkers through the years has not been an easy achievement (Christal & Weissmuller, 1988), nor was acceptance immediate or widespread (Christal, 1974a). Job and occupational analysis is not a glamorous or high visibility area on which to build a personal career or secure tenure. Cunningham (as cited in Harvey, 1991) observed that it is difficult to get students interested or to get reports accepted for publication; he once characterized the job analysis area as "the Rodney Dangerfield of I/O [industrial/organizational] psychology; it doesn't get a lot of respect" (p. 73). The R&D community as a whole (across several academic disciplines) generally has not been enthusiastic about the largely atheoretical job analysis area.

However, the task-based approach to job analysis has gradually gained wide acceptance within the military services and in allied services (Mitchell, 1988; Sellman, 1995). Its use has spread to the academic world, to business and industry, and to state and local government (see Figure 1). Ammerman and his coworkers at the National Center for Research in Vocational Education at Ohio State University created a central library of task lists and published a five-volume set of booklets on the task inventory approach for determining performance content for job training (Ammerman & Pratzner, 1977). Task-based approaches have been used in a variety of civilian activities including the Work Performance Survey System at American Telephone and Telegraph (Gael, 1983) and Page and Caskey's (1988) Occupational Analysis Questionnaire (see also Drauden's, 1988, discussion of task inventory analysis in industry and the public sector).

CODAP software has recently been upgraded and standardized across the U.S. and Allied military services (Phalen & Mitchell, 1993). CODAP can also interface with other software systems; CODAP files can be extracted and exported to general statistical packages, such as SPSS or SAS (Weissmuller & Staley, 1995). Likewise, other types of data (such as critical incident, skills and knowledges, attribute requirements, etc.) can and are being processed in CODAP (see Driskill et al., 1989; Goldman, 1991a; Moon et al., 1991). Data files are routinely exchanged among computers via tape or transmission networks as well as among hardware systems. A microcomputer version, called atCODAP, has been created and is now being used by a variety of governmental agencies and other enterprises (Weissmuller & Staley, 1995; Weissmuller, Staley, Lewis, & Johnson, 1987). This system includes automated task inventory development as well as computer-based survey administration and disk storage and transmittal of survey responses. A computer-based task inventory administration system is currently under development for the Air

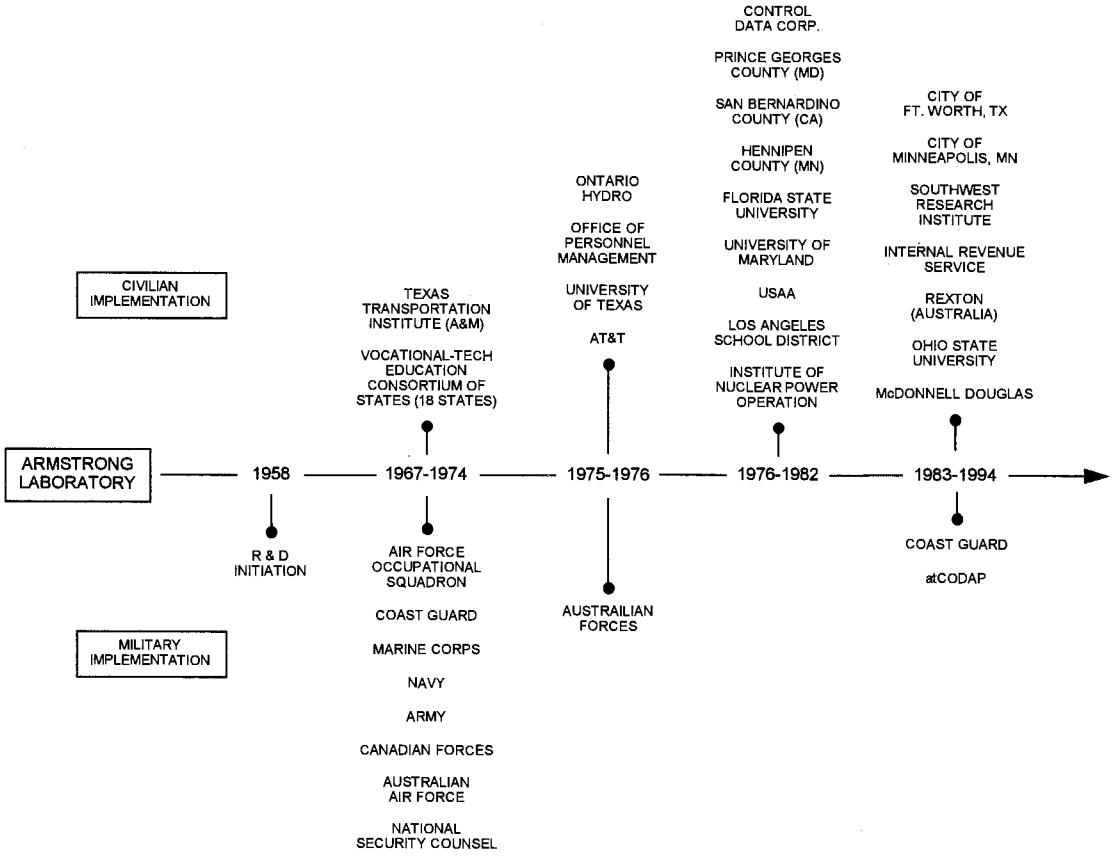

FIGURE 1 Transfer of Comprehensive Occupational Data Analysis Programs (CODAP) technology to other military and civilian organizations.

Force OAP (Albert et al., 1994; Mitchell et al., 1994; Mitchell, Weissmuller, Bennett, Agee, & Albert, 1995).

EVALUATIONS OF MILITARY OCCUPATIONAL ANALYSIS

Moore (1976), in a review of job analysis methodologies for the Navy, viewed modern task inventories as a synthesis of three different approaches to job design: the engineering, job content, and role content approaches (see also his Figure 1). Moore concluded his review with the comment that "the relevance, utility, and comprehensiveness of the task-based CODAP approach seems to offer a significant step forward over other forms of occupational analysis" (p. 75).

McCormick (1979) disagreed with Moore's (1976) assessment, although he conceded that task inventories were particularly useful for identifying job types and planning training programs, and went on to point out that "each of the various individual methods has its own potential uses, and it does not seem reasonable to believe that there is one best method that can serve all purposes" (p. 135).

Levine, Thomas, and Sistrunk (1988) evaluated a number of job analysis methodologies to determine which systems are most useful for various purposes. They used data from a nationwide survey of 93 leading job-occupational analysts who rated the characteristics and utility of various established systems including McCormick's Position Analysis Questionnaire (PAQ), Fine's Functional Job Analysis (FJA), the task inventory–CODAP approach, Flanagan's Critical Incident Technique (CIT), Primoff's Job Elements Method (JEM), Fleishman's ARS, and Lopez's Threshold Traits Analysis. The PAQ, FJA, and the task inventory–CODAP approaches were generally rated among the top three methods for most uses. In addition, 80 of the 93 analysts indicated that they preferred to use a combination of two methods to meet their needs (Levine et al., 1988). The most popular combinations included CODAP and PAQ, CIT and FJA, FJA and CODAP, PAQ and CIT, and CODAP and ARS. This survey provided, for the first time, a high level of visibility for CODAP among academics, human resource managers, and other job analysis practitioners.

These combinations of preferred methods typically include an occupation-specific method with a method that permits comparisons across occupations. For example, whereas CODAP studies include tasks relevant to one occupation (or a small number of closely related occupations), PAQ produces general dimension scores relevant for comparison of all occupations. Thus, analyst preference for more than one method can be understood as servicing a need for more than one perspective in the effort to understand jobs and occupations.

It is significant that at least three of these methods, CODAP, PAQ, and CIT, evolved directly from military job analysis research; and at least two others, JEM

and FJA, evolved from other government agencies. Other researchers, such as Fleishman, worked closely with and were often supported by military R&D agencies. The point is that a very substantial proportion of job analysis research in this country has been directly accomplished by, or directly or indirectly supported by, the military services and other government agencies.

The most recent comprehensive review of the job analysis area is that of Harvey (1991). Harvey recognized the possible value of the military task-based approach in the area of training specification. His literature citations do not include most of the more recent military technical reports involving job analysis and the modeling or assessment of military occupations. This may be primarily a function of the limited availability of military technical reports and the lack of publishing about such military R&D in the I/O psychology literature.

CURRENT TRENDS

The existence of many approaches and methods has led many to conclude that the job analysis area lacks focus and a well-developed theoretical base (as compared to the testing of individual ability differences). Some I/O psychologists (as well as managers, trainers, and others) perceive job analysis as an empirical process that has evolved through pragmatic use, and they believe it has little implication for future I/O psychology research and theory (Blum & Naylor, 1968). However, most I/O scientists and practitioners would agree that job analysis is absolutely necessary as a foundation for selection, classification, testing, and training programs, not only because the law requires it, but also because it provides a scientific basis for defining requirements and validating such programs (Harvey, 1991). A careful review of the job analysis literature indicates that there are indeed several theoretical models that have been used for the study of human work in recent decades.

Theoretical Developments

McCormick (1979) noted that the task perspective of the world of work utilizes the "so-called S → O → R model" in which a stimulus (S) acts on the organism (O) to bring about a response (R). This model permits the description and specification of a job in terms of all the actions that must be performed and the analysis of such actions in terms of equipment used, decisions required, or action responses (such as the operation of control mechanisms). This paradigm, originally formulated by Miller (1953), was used extensively in task–equipment analysis and man–machine analysis in the military services.

Flanagan (1949, 1951), who took a slightly different approach to examining performance, maintained that performance could best be assessed by how well

significant or critical tasks or activities were performed. Flanagan's studies led to the development of the CIT for identifying and assessing the important dimensions of work performance. The CIT is based on a content analysis of critical incident descriptions collected from job incumbents. This technique has gained wide acceptance in American I/O psychology, and many of Flanagan's performance dimensions survive as the factors to be rated in various military and civilian performance rating systems (such as planning, directing, supervising, etc.).

Although Flanagan (1949, 1951) did not explicitly formulate a theoretical model, the implied model in his work is a linear, additive one; that is, performance is a function of performance on Critical Task 1 plus performance on Critical Task 2, and so forth:

$$P = f(t_1 + t_2 + t_3 \ldots t_n).$$

In some circumstances, tasks might be weighted differentially by using a measure of criticality as the weight for each task or activity (cf. Goldman, 1991b) to reduce the number of tasks that should be considered for some purpose. For example, it would be reasonable to deal with critical tasks only when assessing performance as an indicator of promotion possibility or for identifying performance dimensions potentially useful in selection. For other purposes, such as development or validation of training, some other weighting factor might be more appropriate, such as the difficulty of the task to learn or perform.

By extension, the previously noted military task-based approach used by the U.S. and Allied services can be said to have evolved from Flanagan's approach. Military occupational analysis is also based on a linear, additive model, in which overall job performance is considered to be the sum of performance on specific occupational tasks. In both Flanagan's (1949, 1951) work and the military task-based approach, such models are occupation-specific because the particular set of activities or tasks is unique to each specialty or occupation.

Much of the theoretical work in civilian I/O psychology over the last 20 years has focused on the roles of abilities and motivation in human work performance. Typically, performance is conceptualized as some function of abilities and motivation; many researchers hypothesized that the function involved is a multiplicative one.

Naylor, Pritchard, and Ilgen (1980) developed a general model of performance in terms of cognitive, affective, and behavioral factors. Russell (1985), who felt their model lacked recognition of job and task variations, built on their foundation to create a more sophisticated model that integrated job performance and training and showed how training influences the individual's on-the-job performance and behavior. A similar criticism could be made of recent military selection models that focus on ASVAB composites as the primary predictors of job performance (cf. McCloy, Harris, & Hedges, 1991).

Indeed, some of the more interesting theoretical developments in recent years have come from the training evaluation area and associated work in improved job performance assessment. Realistic training, like good performance measurements, must be based on systematic job and task analysis to define and quantify actual job performance requirements. "Training validity refers to the establishment of treatment effects as a result of the instructional program," whereas performance validity involves establishing whether learning has "positively transferred from the training program to the on-the-job environment" (Goldstein, 1978, pp. 133–136). Training validity is essential for performance validity, but it does not assure transfer (Bunker & Cohen, 1977).

In a project to assess realistic job measures as potential criteria for evaluating training, Driskill, Mitchell, and Ballentine (1985) postulated a more complex model by superimposing a major training component onto the Kavanaugh, Borman, Hedge, and Gould (1987) job performance model. The resulting composite model suggested that job performance is a function not just of an individual's ability but also of the validity of training received as well the individual's interaction with the supervisor and work group. Performance is also moderated, as Kavanaugh et al. noted, by organizational factors, stressful life events (emotion), and other nonjob variables. Perhaps one should not expect to find a simple, direct correlation between individual ability and ultimate job performance; performance is a complex phenomenon that is determined by a variety of factors (Mitchell & Driskill, 1986).

If we are ever to understand how to properly select, classify, train, and assess human performance in various occupations, we need an integrated framework that reflects both the requirements of jobs and the complex variables (including organizational factors) that bear on human performance in meeting such job requirements (Vaughan & Bennett, 1993). Such an integrating schema holds the potential for helping to understand how the various job analysis objectives (selection, training, performance appraisal, career development, etc.) might best be served by a detailed but flexible task-based job analysis approach, by which information can be aggregated or cross-mapped to other domains (abilities, knowledges, work conditions, etc.) as needed (Ward, Mitchell, Weissmuller, & Vaughan, 1993).

"*g*-ocentric" Versus Job-Specific Approaches

The current controversy over general cognitive abilities (Ree, Earles, & Teachout, 1994; Sternberg, Wagner, Williams, & Horvath, 1995) also has some implications for the future of military job analysis. Hunter argued that "general cognitive ability has high validity predicting performance ratings and training success in all jobs" (as cited in Ree, Carretta, & Teachout, 1995, p. 721).

Sternberg et al. (1995) pointed out that conventional intelligence test scores typically account for much less than half of the variance in individual performance.

Sternberg et al. emphasized the need for using new measures of "practical intelligence" (p. 924) in addition to traditional measures of *g*. Such measures of practical intelligence include assessment of problem-solving ability or other forms of "tacit knowledge" (p. 918) that are involved in the normal work environment. In their more recent work, Ree et al. (1995) showed that although more specific "prior job knowledge" (p. 721) has almost no influence on subsequent job knowledge, it directly influences early work sample tests, and early training job knowledge influences subsequent job knowledge and work sample performance.

This emphasis on *g* versus more specific (*s*) abilities or factors has been taken by some to imply that detailed job analysis, such as the task-based approach used by the military services, is not needed because *g* alone is adequate for selecting new military personnel. Cascio (1995), for example, recently observed a "detectable shift away from a task-based toward a process-based organization of work" (p. 932). He went on to ask:

> What will be the future of traditional task-based descriptions of jobs and job activities? Should other types of descriptors replace task statements that describe what a worker does, to what or whom, why, and how? Will "task cluster" statements or "subprocess" statements become the basic building blocks for describing work? (p. 932)

Perhaps the issue is not an either–or question; a more relevant question is, How can task-based information, which has proven so useful in assessing the specialized training requirements of the highly varied military specialties, be supplemented or augmented by other assessments of job requirements in terms of skill and knowledge needs?

In a recent effort, Driskill et al. (1989) examined 36 job analytic methods to determine how ability requirements could best be linked to task-level job data. As a result, a combination of CODAP and the ARS was successfully employed. Another application demonstrated how knowledge and skill taxonomies can be used with CODAP-generated task coperformance modules to define training and testing requirements empirically (Moon et al., 1991). Linkages of this kind are essential if we are to have legally defensible occupational requirements, realistic recruiting standards, optimal classification and placement, and realistic training programs.

Such linkages are possible only if current methods are extended and a variety of methods are utilized. Recent and ongoing research is addressing the use of multiple approaches, including the ARS and CIT, in conjunction with CODAP. Further, the analytic capabilities of CODAP are being extended and applied to practical personnel and training problems. CODAP data files can be exported to other analysis systems (such as SAS or SPSS), and other files can also be imported into CODAP so that this system has become a more interactive technology (Weissmuller & Staley, 1995).

In particular, the task coperformance module technology is extremely promising for defining classification structures that optimize transfer of training and for the empirical determination of skill and knowledge requirements. Task modules also have been used extensively as a basis for modeling specialty jobs and training requirements (see Chin et al., 1992), and have high potential utility in multilevel organizational research (Mitchell, Phalen, & Hand, 1992; Vaughan & Yadrick, 1992). In a recent experimental study, ratings of task modules on 26 skill and knowledge scales proved predictive of learning curves (training time functions); this approach has potential for estimating training requirements of new weapons systems (Vaughan, Mitchell, Knight, Bennett, & Buckenmyer, 1990).

Task modules, particularly mission essential modules (i.e., those groups of tasks that are critical to the mission of an organization or work unit, such as repairing mission-ready airplanes), recently have been accepted as an appropriate level of analysis for a specialty structuring system and for a variety of other purposes. Modules developed on the basis of computed average task coperformance probabilities also have been successfully used in some non-Department of Defense (DOD) research (see Moon et al., 1991) and appear to have a number of realistic and practical applications (Phalen & Mitchell, 1993).

A number of recent CODAP-related research and applications have been accomplished for nonmilitary organizations and businesses (cf. Stone, Weissmuller, & Mitchell, 1995; Tsai, 1993; Weissmuller & Staley, 1995), and this trend is expected to continue. There have been several uses of the task modules technology with civilian companies and non-DOD organizations, and there appears to be considerable interest in making further applications of military-developed job analysis technology for civilian use.

Finally, Sellman (1995) challenged military occupational analysts to think beyond their current programs and missions and to anticipate service-wide programs or uses across agencies of the federal government or joint government–business applications. Joint activities with allied military services and governments are also highly probable.

CONCLUSIONS

Considerable work is needed to assess specific job needs as well as to develop a unified theory of work, but we believe that military job analysis during the last 40 years has created a firm foundation upon which such needs and theory can be elaborated. Although much of this work has not been well publicized or understood in the civilian arena, we believe that it is directly and immediately applicable to most civilian occupations. Where the technologies have been used in the civilian world of work, they have been found both applicable and highly useful. Additional research and development is needed, particularly the development of data collection software and modeling systems technologies for improved decision making and

enhancing individual and organizational productivity (Ward, Vaughan, Mitchell, Driskill, & Ruck, 1992).

REFERENCES

Albert, W. G., Phalen, W. J., Selander, D. M., Dittmar, M. J., Tucker, D. L., Hand, D. K., & Weissmuller, J. J. (1994). Large-scale laboratory test of occupational survey software and scaling procedures. In *Proceedings of the 36th Annual Conference of the International Military Testing Association* (pp. 241–246). Rotterdam, The Netherlands: European Members of the IMTA.

Ammerman, H. L., & Pratzner, F. C. (1977). *Performance content for job training* (Research and Development Series No. 121). Columbus: Ohio State University, Center for Vocational Education.

Archer, W. B. (1966). *Computation of group job descriptions from occupational survey data* (Rep. No. PRL–TR–66–12). Lackland Air Force Base, TX: Personnel Research Laboratory, Aerospace Medical Division.

Archer, W. B., & Fruchter, B. A. (1963). *The construction, review, and administration of Air Force job inventories* (Rep. No. PRL–TDR–63–21). Lackland Air Force Base, TX: 6570th Personnel Research Laboratory.

Ash, R. A. (1988). Job analysis in the world of work. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 1, pp. 205–215), New York: Wiley.

Blum, M. S., & Naylor, J. C. (1968). *Industrial psychology.* New York: Harper & Row.

Bunker, K. A., & Cohen, W. L. (1977). The rigors of training evaluation: A discussion and field evaluation. *Personnel Psychology, 30,* 525–541.

Burtch, L. D. (1978). A methodology to evaluate the aptitude requirements of Air Force jobs. In *Proceedings of the 20th Annual Conference of the Military Testing Association* (pp. 1012–1025). Oklahoma City, OK: U.S. Coast Guard Institute.

Burtch, L. D., Lipscomb, M. S., & Wissman, D. J. (1982). *Aptitude requirements based on task difficulty: Methodology for evaluation* (Rep. No. AFHRL–TR–81–34, AD–A110 568). Brooks Air Force Base, TX: Air Force Human Resources Laboratory, Manpower and Personnel Division.

Cascio, W. F. (1995). Whither industrial and organizational psychology in a changing world of work? *American Psychologist, 50,* 928–939.

Chin, K. B. O., Lamb, T. A., Bennett, W. R., & Vaughan, D. S. (1992). *Introduction to training decisions modeling technologies: The training decisions system* (Rep. No. AL–TP–1992–0014). Brooks Air Force Base, TX: Armstrong Laboratory, Human Resources Directorate, Technical Training Research Division.

Christal, R. E. (Ed.). (1974a). *Proceedings of the Division 19, Military Psychology Symposium: Collecting, analyzing, and reporting information describing jobs and occupations* (Rep. No. AFHRL–TR–74–19). Lackland Air Force Base, TX: Air Force Human Resources Laboratory, Occupational Research Division.

Christal, R. E. (1974b). *The United States Air Force occupational research project* (Rep. No. AFHRL–TR–73–75, AD–774 574). Lackland Air Force Base, TX: Air Force Human Resources Laboratory, Occupational Research Division.

Christal, R. E., & Weissmuller, J. J. (1988). The job-task inventory. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 2, pp. 1036–1050). New York: Wiley.

Cronbach, L. J., & Snow, R. E. (1977). *Aptitude and instructional methods.* New York: Wiley.

Cunningham, J. W. (1988). Occupational Analysis Inventory. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 2, pp. 975–990). New York: Wiley.

Cunningham, J. W., Wimpee, W. E., & Ballentine, R. D. (1990). Some general dimensions of work among U.S. Air Force enlisted occupations. *Military Psychology, 2,* 33–45.

Drauden, G. M. (1988). Task inventory analysis in industry and the public sector. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 2, pp. 1051–1071). New York: Wiley.

Driskill, W. E., Mitchell, J. L., & Ballentine, R. (1985). *Using job performance as a criteria for evaluating training effectiveness* (Draft technical report prepared for the Training Systems Division, Air Force Human Resources Laboratory). San Antonio, TX: MAXIMA.

Driskill, W. E., Weissmuller, J. J., Hageman, D. C., & Barrett, L. E. (1989). *Identification and evaluation of methods to determine ability requirements for Air Force occupational specialties* (Rep. No. AFHRL–TP–89–34). Brooks Air Force Base, TX: Air Force Human Resources Laboratory, Manpower and Personnel Division.

DuBois, P. H. (1970). *A history of psychological testing.* Boston: Allyn & Bacon.

Fine, S. A. (1988). Functional job analysis. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 2, pp. 1019–1035). New York: Wiley.

Fine, S. A., & Wiley, W. W. (1971). *An introduction to functional job analysis.* Kalamazoo, MI: W. E. Upjohn Institute for Employment Research.

Flanagan, J. C. (1949). *Critical requirements for research personnel: A study of observed behaviors of personnel in research laboratories.* Pittsburgh, PA: American Institute for Research.

Flanagan, J. C. (1951). The critical incident technique. *Psychological Bulletin, 51,* 327–358.

Fleishman, E. A., & Mumford, M. D. (1988). Ability requirements scales. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 2, pp. 917–935). New York: Wiley.

Fleishman, E. A., & Quaintance, M. K. (1984). *Taxonomies of human performance.* New York: Academic.

Fleishman, E. A., & Reilly, M. E. (1992). *Handbook of human abilities: Definitions, measurements, and job task requirements.* Palo Alto, CA: Consulting Psychologists Press.

Fugill, J. W. K. (1972). *Task difficulty and task aptitude benchmark scales for the mechanical and electronics career fields* (Rep. No. AFHRL–TR–72–40, AD–754 848). Lackland Air Force Base, TX: Air Force Human Resources Laboratory, Personnel Research Division.

Fugill, J. W. K. (1973). *Task difficulty and task aptitude benchmark scales for the administrative and general career fields.* Lackland Air Force Base, TX: Air Force Human Resources Laboratory, Personnel Research Division.

Gael, S. (1983). *The job analysis: A guide to assessing work activities.* San Francisco: Jossey-Bass.

Gael, S. (Ed.). (1988). *The job analysis handbook for business, industry, and government.* New York: Wiley.

Gagne, R. M. (1977). *The conditions of learning* (3rd ed.). New York: Holt, Rinehart & Winston.

Garcia, S. K., Ruck, H. W., & Weeks, J. (1985). *Benchmark learning difficulty technology: Feasibility of operational implementation* (Rep. No. AFHRL–TP–85–33). Brooks Air Force Base, TX: Air Force Human Resources Laboratory, Manpower and Personnel Research Division.

Goldman, L. A. (1991a). Comparative cluster analysis of skills, knowledge, and ability items based on occupational survey data. In *Proceedings of the Seventh Occupational Analysts Workshop* (pp. 48–65). San Antonio, TX: USAF Occupational Measurement Squadron.

Goldman, L. A. (1991b). Effect of varying training emphasis weights in task criticality model. In *Proceedings of the 33rd Annual Conference of the Military Testing Association* (pp. 287–292). San Antonio, TX: Armstrong Laboratory, Human Resources Directorate and the USAF Occupational Measurement Squadron.

Goldstein, I. L. (1978). The pursuit of validity in evaluation of training programs. *Human Factors, 20,* 131–144.

Harding, F. D., Mumford, M., & Weeks, J. L. (1985). Causes of performance in Air Force initial skills training. In *Proceedings of the 27th Annual Conference of the Military Testing Association* (Vol. 2, pp. 467–472). San Diego, CA: Navy Personnel Research and Development Center.

Harvey, R. J. (1991). Job analysis. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of industrial & organizational psychology* (Vol. 2, pp. 71–163). Palo Alto, CA: Consulting Psychologists Press.

Kavanaugh, M. J., Borman, W. C., Hedge, J. W., & Gould, R. B. (1987). *Job performance measurement in the military: A classification scheme, literature review, and directions for research* (Rep. No. AFHRL–TR–87–15). Brooks Air Force Base, TX: Air Force Human Resources Laboratory, Training Systems Division & Manpower and Personnel Research Division.

Levine, E. L., Thomas, J. N., & Sistrunk, F. (1988). Selecting a job analysis approach. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 1, pp. 339–352). New York: Wiley.

Madden, J. M. (1962). What makes work difficult. *Personnel Journal, 41,* 341–344.

Madden, J. M., Hazel, J. T., & Christal, R. E. (1964). *Worker and supervisor agreement concerning the worker's job description* (Rep. No. PRL–TDR–64–10). Lackland Air Force Base, TX: 6570th Personnel Research Laboratory, Aerospace Medical Division.

McCloy, R. A., Harris, D. A., & Hedges, L. V. (1991). A multilevel model of job performance: The primary linkage equation. In *Proceedings of the 33rd Annual Conference of the Military Testing Association* (pp. 126–131). San Antonio, TX: Armstrong Laboratory, Human Resources Directorate and the USAF Occupational Measurement Squadron.

McCormick, E. J. (1960). *Effect of amount of job information required on reliability of incumbents' check-list reports* (Rep. No. WADD–TN–60–142). Lackland Air Force Base, TX: Personnel Research Laboratory, Wright Air Development Division.

McCormick, E. J. (1967). Opportunities for research in the military services. In A. L. Fortuna (Ed.), *Personnel research and systems advancement: Proceedings of the 25th Anniversary Symposium* (Rep. No. PRL–TR–67–13, pp. 121–127). Lackland Air Force Base, TX: Personnel Research Laboratory.

McCormick, E. J. (1979). *Job analysis: Methods and application.* New York: AMACOM.

McCormick, E. J., & Tiffin, J. (1974). Industrial psychology (6th ed.). Englewood Cliffs, NJ: Prentice-Hall.

McCormick, E. J., & Tombrink, K. B. (1960). *A comparison of three types of work activity statements in terms of the consistency of job information reported by incumbents* (Rep. No. WADD–TR–60–80). Lackland Air Force Base, TX: Personnel Laboratory, Wright Air Development Division.

Miller, R. B. (1953). *A method for man–machine task analysis* (Rep. No. WADC–TR 53–137). Wright–Patterson Air Force Base, OH: Wright Air Development Center.

Miller, R. B. (1973). Development of a taxonomy of human performance: Design of a systems task vocabulary. *JSAS Catalog of Selected Documents in Psychology, 3,* 29–30.

Mitchell, J. L. (1988). History of job analysis in military organizations. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 1, pp. 30–36). New York: Wiley.

Mitchell, J. L., & Driskill, W. E. (1986, August). Optimizing integrated personnel system training decisions and development. In W. W. Tornow (Chair), *State-of-the-art applications of job analysis: Integrated personnel systems.* Symposium conducted at the 93rd annual meeting of the American Psychological Association, Washington, DC.

Mitchell, J. L., Phalen, W. J., & Hand, D. K. (1992). Multilevel occupational analysis: Hierarchies of tasks, modules, jobs, and specialties. In *Proceedings of the 34th Annual Conference of the Military Testing Association* (pp. 729–734). San Diego, CA: Navy Personnel Research and Development Center.

Mitchell, J. L., Ruck, H. W., & Driskill, W. (1988). Task-based training program development. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 1, pp. 205–215). New York: Wiley.

Mitchell, J. L., Weissmuller, J. J., Bennett, W., Jr., Agee, R. C., & Albert, W. G. (1995). Final results of a feasibility study of computer-assisted occupational surveys. In *Proceedings of the 37th Annual*

Conference of the International Military Testing Association. Toronto: Canadian Forces Applied Research Unit.

Mitchell, J. L., Weissmuller, J. J., Bennett, W., Jr., Agee, R. C., Albert, W. G., & Selander, D. M. (1994). A field study of automated occupational survey administration methods. In *Proceedings of the 36th Annual Conference of the International Military Testing Association* (pp. 253–258). Rotterdam, The Netherlands: European Members of the IMTA.

Mitchell, J. L., Yadrick, R. M., & Bennett, W. R. (1993). Estimating training requirements from job and training models. *Military Psychology, 5,* 1–20.

Moon, R. A., Driskill, W. E., Weissmuller, J. J., Strayer, S. J., Fisher, G. P., & Kirsh, M. (1991). Using task co-performance modules to define job requirements. In *Proceedings of the 33d Annual Conference of the Military Testing Association* (pp. 243–252). San Antonio, TX: Armstrong Laboratory Human Resources Directorate and the USAF Occupational Measurement Squadron.

Moore, B. E. (1976). *Occupational analysis for human resource development: A review of utility of the task inventory* (Research Rep. No. 25). Washington, DC: Department of the Navy, Office of Civilian Manpower Management, Management Sciences Branch.

Morsh, J. E. (1964). Job analysis in the United States Air Force. *Personnel Psychology, 17,* 7–17.

Morsh, J. E. (1965). *Evolution of a job inventory and tryout of task rating factors* (Rep. No. PRL–TR–65–22). Lackland Air Force Base, TX: Personnel Research Laboratory, Aerospace Medical Division.

Morsh, J. E., Madden, J. M., & Christal, R. E. (1961). *Job analysis in the United States Air Force* (Rep. No. WADD–TR–61–113). Lackland Air Force Base, TX: Personnel Laboratory, Wright Air Development Division.

Mumford, M. D., Weeks, J. L., Harding, F. D., & Fleishman, E. A. (1985). *An empirical system for assessing the impact of aptitude requirement adjustments on Air Force initial-skills training.* Brooks Air Force Base, TX: Air Force Human Resources Laboratory, Manpower and Personnel Division.

Naylor, J. C., Pritchard, R. D., & Ilgen, D. R. (1980). *A theory of behavior in organizations.* New York: Academic.

Page, R. C., & Caskey, D. T. (1988). Computer programmer. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 2, pp. 1192–1205). New York: Wiley.

Phalen, W. J., & Mitchell, J. L. (1993). Innovations in occupational measurement technology for the U.S. military. In *Proceedings of the Eighth International Occupational Analysts Workshop* (pp. 12–16). San Antonio, TX: USAF Occupational Measurement Squadron.

Primoff, E. S., & Fine, S. A. (1988). A history of job analysis. In S. Gael (Ed.), *The job analysis handbook for business, industry, and government* (Vol. 1, pp. 14–29). New York: Wiley.

Ramadge, J. D. (1987). *Task learning difficulty: Interrelationships among aptitude-specific benchmarked rating scales* (Rep. No. AFHRL–TP–86–56). Brooks Air Force Base, TX: Air Force Human Resources Laboratory, Manpower and Personnel Division.

Ree, M. J., Carretta, T. R., & Teachout, M. S. (1995). Role of ability and prior job knowledge in complex training performance. *Journal of Applied Psychology, 80,* 721–730.

Ree, M. J., Earles, J. A., & Teachout, M. S. (1994). Predicting job performance: Not much more than *g. Journal of Applied Psychology, 79,* 518–524.

Rose, A. M., Czarnoiewski, M. Y., Gragg, F. H., Austin, S. H., Ford, P., Doyle, J., & Hagman, J. D. (1984). *Acquisition and retention of soldiering skills* (Contract No. 1MDA–81–C–AA01). Washington, DC: U.S. Army Institute.

Ruck, H. W., Thompson, N. A., & Stacy, W. J. (1987). *Task training emphasis for determining training priority* (Rep. No. AFHRL–TP–86–65). Brooks Air Force Base, TX: Air Force Human Resources Laboratory, Manpower and Personnel Division.

Rupe, J. C. (1952). *Research into basic methods and techniques of Air Force job analysis: I* (Rep. No. AFPTRC–52–16). Lackland Air Force Base, TX: Air Force Personnel & Training Research Center.

Rupe, J. C. (1956). *Research into basic methods and techniques of Air Force job analysis: IV* (Rep. No. AFPTRC–56–51). Lackland Air Force Base, TX: Air Force Personnel & Training Research Center.

Russell, J. S. (1985, August). A model of effective training. In J. S. Russell (Chair), *Towards theories of training effectiveness.* Symposium conducted at the 92nd annual meeting of the American Psychological Association, Los Angeles, CA.

Sellman, W. S. (1995). Since we are reinventing everything else, why not occupational analysis? In *Proceedings of the Ninth International Occupational Analysts Workshop* (pp. 8–18). San Antonio, TX: USAF Occupational Measurement Squadron.

Shartle, C. L. (1959). *Occupational information* (3rd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Sternberg, R. J. (1982). Natural, unnatural and supernatural concepts. *Cognitive Psychology, 15,* 121–149.

Sternberg, R. J., Wagner, R. K., Williams, W. M., & Horvath, J. A. (1995). Testing common sense. *American Psychologist, 50,* 912–927.

Stone, B. M., Turner, K. L., Looper, L. T., & Skinner, M. J. (1994). An occupational survey-based approach to measuring personnel productivity. In *Proceedings of the 36th Annual Conference of the International Military Testing Association* (pp. 234–240). Rotterdam, The Netherlands: European Members of the IMTA.

Stone, B. M., Weissmuller, J. J., & Mitchell, J. L. (1995). Occupational analysis data and MPT: Related research and development. In *Proceedings of the Ninth International Occupational Analysts Workshop* (pp. 19–26). San Antonio, TX: USAF Occupational Measurement Squadron.

Thorndike, R. L., Hagen, E. P., Orr, D. B., & Rosner, B. (1957). *An empirical approach to the determination of Air Force job families* (Rep. No. AFPTRC–TR–57–5). Lackland Air Force Base, TX: Air Force Personnel and Training Research Center.

Tsai, C. (1993, June). Seeking out engineering training needs: A computer-based survey can provide answers. *Technology Today.* San Antonio, TX: Southwest Research Institute.

Van Cleve, R. R. (1974). Collecting, analyzing, and reporting information describing jobs and occupations. In R. E. Christal (Ed.), *Proceedings of the Division 19, Military Psychology Symposium: Collecting, analyzing, and reporting information describing jobs and occupations* (Rep. No. AFHRL–TR–74–19, pp. 65–70). Lackland Air Force Base, TX: Air Force Human Resources Laboratory, Occupational Research Division.

Vaughan, D. S. (1978). Two applications of occupational survey data in making training decisions. In *Proceedings of the 20th Annual Conference of the Military Testing Association* (Vol. 1, pp. 213–217). Oklahoma City, OK: U.S. Coast Guard Institute.

Vaughan, D. S., & Bennett, W. R. (1993). Toward a unified theory of work: Organizational simulations and policy analyses. In *Proceedings of the 35th Annual Conference of the Military Testing Association* (pp. 31–36). Williamsburg, VA: U.S. Coast Guard Headquarters, Occupational Analysis Program.

Vaughan, D. S., Mitchell, J. L., Knight, J. R., Bennett, W. R., & Buckenmyer, D. V. (1990). Developing a training time and proficiency model for estimating Air Force specialty training requirements of new weapons systems. In *Proceedings of the 34th Annual Conference of the Military Testing Association* (pp. 116–121). Orange Beach, AL: Naval Education and Training Program Management Support Activity.

Vaughan, D. S., & Yadrick, R. M. (1992). An organizational analysis simulation technology. In *Proceedings of the 34th Annual Conference of the Military Testing Association* (pp. 735–740). San Diego, CA: Navy Personnel Research and Development Center.

Ward, J. H., Jr. (1961). *Hierarchical grouping to maximize payoff* (Rep. No. WADD–TN–61–29, AD–261 750). Lackland Air Force Base, TX: Personnel Laboratory, Wright Air Development Division.

Ward, J. H., Jr., Mitchell, J. L., Weissmuller, J. J., & Vaughan, D. S. (1993). A software system for modeling jobs and people characteristics to help optimize individual and organizational objectives. In *Proceedings of the 35th Annual Conference of the Military Testing Association* (pp. 25–30). Williamsburg, VA: U.S. Coast Guard Headquarters, Occupational Analysis Program.

Ward, J. H., Jr., Vaughan, D. S., Mitchell, J. L., Driskill, W. E., & Ruck, H. W. (1992). The ultimate person–job match: A key to future worker productivity. In *Proceedings of the 34th Annual Conference of the Military Testing Association* (pp. 849–854). San Diego, CA: Navy Personnel Research and Development Center.

Weeks, J. L. (1981). The development and application of measures of occupational learning difficulty. In *Proceedings of the 23rd Annual Conference of the Military Testing Association* (Vol. 2, pp. 1249–1257). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Weeks, J. L. (1984). *Occupational learning difficulty: A standard for determining the order of aptitude requirements minimums* (Rep. No. AFHRL–TR–84–26; A417 410). Brooks Air Force Base, TX: Air Force Human Resources Laboratory, Manpower and Personnel Division.

Weeks, J. L., Mumford, M. D., & Harding, F. D. (1985). Occupational learning difficulty: A construct validation against training criteria. In *Proceedings of the 27th Annual Conference of the Military Testing Association* (pp. 90–95). San Diego, CA: Navy Personnel Research and Development Center.

Weissmuller, J. J., & Staley, M. R. (1995). atCODAP: A model for minimizing logistical requirements. In *Proceedings of the Ninth International Occupational Analysts Workshop* (pp. 84–94). San Antonio, TX: USAF Occupational Measurement Squadron.

Weissmuller, J. J., Staley, M. R., Lewis, T. D., & Johnson, C. A. (1987). atCODAP: Federal power at municipal prices. In *Proceedings of the Sixth International Occupational Analysts Workshop* (pp. 157–166). Randolph Air Force Base, TX: USAF Occupational Measurement Center.